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is equally the case with those, who resolve all virtue into self-love, or benevolence, or regard to utility, or the sense of justice. These are all principles of human nature, and, under certain restrictions, coincide in their operation with the laws of rectitude. This is one among innumerable instances of the provident wisdom and goodness of the great Author of all. Every principle which he has implanted in the heart of man, in its regulated tendency, prompts him to the noblest and best aims. What then is the just conclusion? That rectitude is not founded exclusively in sympathy, or self-love, or benevolence; but is that principle which controls and directs them all. It is in the moral, what attraction is in the natural world; it regulates and guides the whole system of our affections and powers, preserves each in its proper sphere and due subordination to the rest, and conducts man to the proper end of his being; the highest perfection, dignity, and happiness, of his own nature, and the widest display of the glory of his Creator.

Art. XV.—1. *Essay on the Theory of the Earth, by M. Cuvier, perpetual secretary of the French Institute, &c. with mineralogical notes, and an account of Cuvier's geological discoveries, by Professor Jameson; to which are now added Observations on the Geology of North America, illustrated by the description of various organic remains found in that part of the world; by Samuel L. Mitchell, Botan. Mineral. and Zoolog. in Univ. Nov. Eborac. Prof. &c. &c. &c.* 8vo. pp. 431. New York, 1818.

2. *Outlines of the Mineralogy and Geology of Boston and its Vicinity, with a Geological Map, by J. Freeman Dana, M. D. and Samuel L. Dana, M. D. Fellows of the Linnæan Society of New England.* 8vo. pp. 108. Boston, Cummings & Hilliard, 1818.

Notwithstanding the sneer of Bishop Watson, that "a gnat essaying the feeble efforts of his slender proboscis against the hide of the elephant, and attempting thereby to investigate the internal formation of that large animal is no unapt representation of man attempting to explore the internal structure of the earth by digging little holes into its surface,"—endeavours to ascertain the earth's structure, and thence to deduce some knowledge of the revolutions, which have taken place in it, are pursued with an ardour constantly increasing. The perfection attained by Astronomy, to which the attention of men was early attracted by the number and splendour of the objects about which it treats, not only satisfies the curiosity of inquirers into the operations of nature, thus leaving them at leisure to direct their attention to the structure and history of the earth, but affords the strongest encouragement to this pursuit. For since the sagacity and ingenuity of man have enabled him to ascertain the form, size, distance, comparative weight and slightest motions of those vast and remote orbs, which are within the reach of only one of his senses, and whose actual motions are imperceptible even by that; what may not be expected from the employment of the same faculties in the examination of the globe, on which we dwell, whose surface we can handle and penetrate, whose materials are accessible to all our senses, and may be submitted to the action of the strongest mechanical and chemical agents? In this, as in every department of natural science, the first rational advance towards the establishment of a system is the accumulation of facts, on which it may be founded. But even philosophers are not always rational; and almost every geologist of the last century seems to have thought it incumbent on him to proclaim some new theory with regard to the formation of the earth consistent with the few facts then known, without waiting for the slow process of observation. These theories were originally unsupported by rational evidence, and most of them have been proved false by subsequent discoveries.

It is becoming every day more difficult to form geological systems, as the increase of knowledge restrains the license of conjecture; for every system ought to explain some of the phenomena observed on the surface or in the structure of our globe, otherwise it would be useless; and to be consistent with them all, otherwise it must be false. These phenomena are now very numerous, consisting of all the facts known with regard to the form and materials of the earth, the situation in which every mineral is found, its connexion with others, the foreign substances contained in it, its constituent parts and the mode of their combination, in short every thing comprised in mineralogy and geology. The present state of these sciences seems to render it incredible that the facts already ascertained by them should be satisfactorily explained by any other hypothesis than the truth; and it is less wonderful that so many theories should be abandoned, than that more than one should still remain and be supported with zeal and confidence. Those of Hutton and of Werner have swallowed up the rest, but are now contending for the mastery with each other. The followers of each introduce various modications in the system of their leader, but all unite in opposition to his adversaries, and finding it more easy to wound their opponents than to secure themselves, commonly prefer an offensive to a defensive warfare; so that some sceptics begin to anticipate that like the soldiers of Jason they will all at last fall in the contest. To make our subsequent remarks more generally intelligible, it may be necessary to state a few of the principal facts, for which the geologist must account, or to which he must at least conform.

On penetrating the surface of the earth, it is found to consist of various distinct layers or strata. Near the level of the sea, these are horizontal; but as we ascend towards the mountains, the edges of other strata lying in a more inclined position than the former and seeming to rise from beneath them, appear on the surface. The strata which form the summits of the secondary mountains and the sides of the highest, are often almost vertical; against these the strata next without them seem to lean, and themselves to pass under those, which are more nearly horizontal and seen at a still lower level. 'When we dig through the horizontal strata in the neighbourhood of the inclined strata, the latter are invariably found below.' The substance, which forms the summits of the loftiest mountains, and against which the highest of the inclined strata rest, is massive granite. This rock does not seem to be stratified, and is of a more crystalline structure than those, which have that appearance. Many strata present very considerable curves, bends and angles, and often appear violently broken, interrupted and displaced; but the same stratum preserves in all its changes of situation the same thickness. From their relative position it is manifest, that if they were successively formed, those nearest the sea are more recent than those, on which they rest, or against which they lean, and which constitute the surface of the earth at a greater height. But were they formed successively? In many of them in every part of the world, at great depths, often imbedded in the hardest rocks, are found the bones and shells of animals and the remains of vegetables. The earth therefore must have been not only formed but inhabited before the consolidation of the rocks, in which these relics of existence are contained. Shells of marine origin are found in more ancient strata than any other animal remains, sometimes it is said more than ten thousand feet above the level of the sea. The opinion of some philosophers, that these were never parts of living beings, but formed by a sport of nature, and that of La Loubere, that they were placed in their present situation by monkies, among whom carrying shells from the sea shore to the tops of the mountains was anciently, as he supposes, a favourite amusement, are neither of them so generally adopted by modern geologists as might be expected from their fondness for daring hypotheses ; but yield to the simpler conclusion that the places where they are discovered were once and for a considerable time covered by the ocean ; so that these mountains must have risen from the bottom of the sea by some mighty revolution, or the sea, by a revolution no less mighty, have abandoned the mountains. Since it is as easy to suppose the mountains elevated or the sea depressed twenty thousand feet as ten thousand, all geologists agree that every part of our globe was once covered by water.

So far we advance in peace,—but here are the limits of controversy, and the point in dispute is no less than this, whether the changes, which have taken place in the structure of the earth's surface, were caused by fire or water. These are by far the most powerful agents, whose operations on it are constantly witnessed, and it was not only natural but philosophical to attempt the explanation of those changes by the accumulation, during a long series of ages, of effects daily produced within our own experience. Hence some supposed with Buffon that our present continents were elevated above the universal ocean by the continued operation of tides and currents, and some that they are the products of extinct volcanoes. Neither of these theories is now maintained in its original simplicity ; for though tides and currents raise sandbanks and form alluvial islands, no experience justifies the assertion that they could consolidate the hardest rocks or elevate the summits of the Andes ; and the products of volcanoes bear evident traces of fire, and after being exposed to intense heat still present this appearance, whereas most mineral substances have their structure totally and irreparably changed by a similar exposure. The two great geological systems however, which now divide the learned, still rely on the agency of these elements, by ascribing to them effects which they are never known actually to produce.

That of Dr. Hutton was first published in the transactions of the Royal Society of Edinburgh for 1775, and has been much more clearly and methodically displayed by Professor Playfair in his illustrations of the Huttonian Theory. Considering it established that all the rocky strata were formed at the bottom of the sea from loose and separate materials, the first question is by what power they were consolidated. We know no way, in which this effect could be produced, unless these materials were crystallized from solution in some fluid, or suffered to cool after being melted or at least softened by heat. The idea of crystallization is rejected by Hutton as inconsistent with the inclined position and uniform thickness of the strata, with the great density of most rocks, and the general insolubility of the substances which compose them. He supposes that their component parts being spread in horizontal layers, in a state of comminution, at the bottom of the sea, were totally or partially melted and thus united into a solid mass; and were elevated into all their present varieties of position by some expansive force acting from below. Both these effects are ascribed to heat existing within the earth; and to the objection that heat could not produce a structure, which is destroyed by fire, it is answered that fire destroys minerals by separating their constituent parts, but if applied to them at the bottom of the ocean, the pressure of the incumbent mass might prevent decomposition, and no other change would be produced than fusion and expansion. Granite, the lowest rock, being nearest to the central fire, was completely fused and forced upward with all the strata resting upon it. Hence it is not distinctly stratified, but of a crystalline structure; while the strata, which lean against it, being exposed to a less intense heat, were only softened and consolidated, and have less and less the appearance of perfect fusion in proportion to their distance from the centre. Thus each of our present continents was raised from the bottom of the sea a vast and shapeless mass of rocks, but the air decomposed its surface, which consisted of the least solid strata, the winds blew and beat upon it, and the rain descended and washed down its fragments towards the ocean. The most elevated parts of the granite were soon exposed, the strata which covered them being crumbled away and spread over their declivities; the torrents hollowed out valleys, and vegetation began to appear. The process is still going on; the frost, the atmosphere, and the rain are constantly decomposing the surfaces of the loftiest and hardest rocks, and the rivers bearing their fragments into the valleys and thence into the sea. These causes are slowly but incessantly breaking down the high places of the earth, and we see no agent employed to repair them. The Huttonian therefore looks forward to the time, distant indeed but certain, when our present continents shall disappear, and their materials be spread over the bottom of the ocean. He looks still further; for why may not the same element, which formed from loose fragments and raised from the bed of the sea the mountains, on whose sides we dwell, consolidate from similar materials and elevate from the same depth other continents, to be again worn down by the agents now destroying these, into heaps of ruins, whence another and another world may rise in indefinite succession? This is exactly the process of Medea, to renovate the decrepitude of the world by cutting it to pieces and boiling it over again.

The theory considers the organic remains imbedded in our rocks as the productions of former continents, which have long since disappeared. In the oldest strata are found small beds of sand, the fragments of mineral bodies, which existed before the present land was formed; and in these beds pieces of sandstone and of other compound rocks, which must have been consolidated from the ruins of a still earlier continent; so that we have clear evidence of two renovations of the earth. Many may have preceded these, but all before them is admitted by the Huttonians themselves to be mere conjecture.

It is not pretended to define the commencement or the conclusion of this series of revolutions; it exhibits no trace of a beginning, no prognostic of an end. Professor Playfair, however, protests against the charge of infidelity; for he asserts, not that the Almighty did not create the world or will not destroy it, but only that there is no visible agent now operating, which must necessarily bring about its destruction. So it is with all the organized productions of nature; the individual dies, but the species continues, and presents no sign of its origin or of its termination. Nor is this series of changes capricious; it is necessary that our globe should be surrounded by air, and consist partly of dry land and partly of water, that the rain should descend and the rivers flow from the mountains to the sea, and that the rocks should be decomposed and their materials accumulated in the valleys in order to support vegetable and animal life. Thus the Huttonian philosopher finds in decay itself the seeds of renovation, and concludes, that while every thing we see is wasting away around us, causes beyond our sight are operating to supply the loss; and that this succession of changes will continue, till the hand, which established the course of nature, be put forth to arrest it, and the voice, that called this beautiful world into existence, speak again to remand it to its original nothing.

Curious and imposing as this theory is, it has at present fewer adherents than that of Werner. That sagacious and indefatigable man, observing the great extent, regular collocation, and different materials of the principal strata of rocks, supposed them all to have been deposited from some aqueous menstruum in their present forms and situations. On this supposition the ocean must have covered the highest mountains, while the strata of granite,—for according to Werner granite is in some sort stratified,—were crystallized. The waters then subsiding, the tops of the granitic rocks appeared above the surface, and those which lean against them and are found only at a less height, were formed. In the same manner, all the strata, which constitute the external crust of the earth, were successively deposited on those immediately preceding them, the water retiring to a lower level after each formation. This ocean, while it covered every part of the globe, was in its most tranquil state; but as it sunk below the summits of the rocks, which had been formed in it, their opposition to the winds and tides occasioned currents, and the decomposition of their surfaces caused fragments to be constantly falling into the surrounding water, and thus disturbed its tranquillity. Hence granite is of a highly crystalline structure, being a purely chemical deposit, while the other strata, formed when the waters were disturbed, are less and less perfectly crystallized in proportion to the recency of their origin; and frequently contain sand and other fragments of rocks of earlier formation. The rocks, in which organic remains are never found, and which are most crystalline, are called primitive, and supposed to have been formed before the creation of organized beings; those containing the remains of vegetables and animals are called secondary, and must have been deposited after the earth was inhabited. The theory distinguishes another class of rocks highly crystalline, but occasionally containing petrifactions, called transition rocks, and said to be formed while the earth was passing from a chaotic to a habitable state. Werner and his disciples do not look back beyond the time when the whole surface of the globe was one fluid mass, nor forward beyond the present.

The numerous facts and analogies adduced by the adherents of each of these systems to support their own opinions and to confute those of their rivals, cannot here be examined nor even recapitulated; but must be sought in the works of their apologists. With regard to most phenomena, both parties seem satisfied with proving that they are not irreconcileable with their respective theories. The instances, in which they endeavour to shew that their favourite agents are capable of producing the effects ascribed to them, are comparatively few, and their arguments in these cases are commonly founded not on close deduction, but on very loose and distant analogies. When closely pressed by an objection, which threatens to be fatal to his system, the geologist defends himself by casting out doubts, which may darken the subject, and thus favour his escape. Every appearance in the structure of rocks inconsistent, according to all experience, with the idea that they have been consolidated by heat, is avoided by the Huttonian, on the ground that nobody knows what may be the effect of heat applied at the bottom of the sea. The insolubility in water of most minerals is answered by the Wernerians with a conjecture that certain minerals, when dissolved in water, may, for aught any body knows, render it capable of dissolving every thing else. Werner's disciples cause all objections to his theory, founded on the relative position of minerals, to disappear instantly by a sort of charm or incantation consisting of two words,—"contemporaneous formation." Are such answers explanations of the facts to which they are applied, or only awkward apologies for ignorance?

But this is not all. The Newtonian rules of philosophizing require that nothing should be assumed as the cause of any phenomena, unless it be proved adequate to their production, and also known to exist. Supposing then the first of these conditions to be fulfilled,—taking it for granted, far as it is from the fact, that each of these theories has shewn the cause, to which it ascribes the structure of the earth's surface, to be sufficient to produce such a structure,—the actual existence of that cause still remains to be established. This requisition is not complied with by proving that there are such elements as fire and water; they must be shewn by induction or analogy to exist in the place and the quantity, which the hypothesis demands. To conclude with Professor Playfair, from the appearance of volcanoes, hot-springs, and earthquakes at the surface of the earth, that the intense and perennial heat, supposed by Hutton, occupies its centre, is a bold deduction. Nor are the disciples of Werner more successful in proving the former existence of an ocean capable of covering the highest mountains, of holding all minerals in solution, of depositing successive strata entirely different, and of retiring after each deposition to a lower level. Of this they adduce no other evidence than the same geological facts, for the purpose of explaining which its existence is assumed. Indeed, what is become of this ocean is a question, which they have not yet answered in a manner satisfactory to any body but themselves. The supposition that it has retired to subterraneous caverns removes the difficulty one step back, only to make way for another. Where are the caverns? Nothing has yet been discovered favourable to the belief of their existence. On the contrary, the vibrations of the pendulum shew that our planet increases in density towards its centre, so that it is estimated to be more than twice as heavy as a solid globe of granite of the same size. Our countryman, Dr. Mitchell, satisfies himself with the following account of the matter.

> 'Difficulties have been raised concerning the subsidence of the primitive ocean. I have published, nine years ago, my opinion that it must necessarily have diminished very considerably for several reasons:—1. A great draught must have been made upon it to form the atmosphere. 2. Another, and a very great portion of it, entered into the constitution of crystals, where it is solidified and embodied. 3. The bodies of vegetables absorb and confine a portion of it. 4. The bodies of animals consolidate or contain much more.'

The atmosphere, if throughout of the same density as at the surface of the earth, would be less than five miles in height.

Oxygen, about one fifth part of the whole, is the only portion of it which enters into the composition of water, to form which it must be combined with twice its bulk of hydrogen. Now granting the philosopher all the hydrogen required, and allowing his experiment to be perfectly successful, he would obtain by it a quantity of water sufficient to raise the ocean not quite thirty feet above its present level. The conjecture that crystals, vegetables and animals have condensed within them fluid enough to raise it nineteen thousand nine hundred and seventy feet higher, is too wild to admit either of proof or of refutation. We might as well employ a comet at once to carry off the superfluous liquid, and thus escape all further questions.

Some geologists refuse to give any answer to the question. The certainty of the fact, say they, is not lessened by our inability to account for it. This is an excellent argument to be addressed to a Wernerian. Undoubtedly, if it be admitted or established that such an ocean did once exist, the theorist need give himself no trouble to account for its disappearance, for we see that it is gone. But when the very question in controversy is, whether there ever were such an ocean, the facts that it is not now in existence, and that if it ever had been, no assignable cause could have removed it, constitute an objection not thus easily to be evaded.

These theories are certainly ingenious conjectures, but failing as they do to shew the existence or the sufficiency of the causes assumed by them, neither can be deemed a philosophical system, nor even, in the present state of the evidence, a probable hypothesis. In what respect are they better supported than the Cartesian system of vortices? We are not however of those, who maintain that no system of geology can ever be established. To judge from analogy with other natural sciences, it may be conjectured, that although the nature of the causes which produced the present structure of the earth's surface should not be ascertained, yet the laws, which regulate their action, may be discovered by observation, and may afford another example how much the operations of nature surpass in grandeur and simplicity the imaginations of men. But whatever may be thought of the probability of these theories, the zeal excited by them has certainly made known many interesting facts. We cannot help listening with diffidence, it is true, to those who go forth determined to make discoveries favourable to their own system and hostile to that of their opponents; the zeal of controversy sometimes warps not only the judgment but the senses, and tempts men to see what does not exist, and to describe what they do not see. It soon however detects the errors, which it has occasioned; the steps of every discoverer are watched and followed by his adversaries, so that his very mistakes often lead ultimately to some new truth. These theories are also highly useful as artificial modes of arranging our geological knowledge, as systems of nomenclature and classification assisting the memory, facilitating the intercourse and directing the researches of the learned.

In the infancy of the science, the attention of geologists was principally devoted to the structure and relative position of minerals. Werner indeed had observed that the different strata may often be distinguished by the difference of the organic remains found in them; that the earliest in which they are found contain only those of fish and testaceous animals, while those of later formation present the bones of birds and quadrupeds; and that the remains inclosed in the most recent strata bear the strongest resemblance to those of animals now existing.

It remained for Cuvier however to make the study of these fossils a distinct science; and much may be expected from its pursuit, for the division of labour is no less advantageous in philosophy than in mechanics. The object of his theory of the Earth is to recommend this science, to display its connexion with geology, to state the principles on which it is founded, the mode of conducting it, and the results which it has already attained.

Its author supposes all the rocky strata to have been formed in a horizontal position at the bottom of the sea, without pretending to understand the process of their consolidation; and to have been subsequently shifted into their present varieties of posture by sudden and violent revolutions, whose causes he does not attempt to explain. The universal dissemination and immense number of organic remains, their relative position, the perfect preservation of their most delicate and brittle parts, prove that they were not transported to their present situations by any external force, but that the animals, to which they belonged, lived and died there. Those animals could exist only on the surface of the earth; the places in which their remains are discovered were once therefore a part of that surface, and continued so long enough for them to attain the perfection which they evidently possessed. Strata containing the relics of animals, which could exist only on dry land, are frequently covered by others filled with marine productions. Such circumstances could not have taken place in consequence of a gradual and regular subsidence of the ocean, and prove that it has made successive irruptions and retreats; which, from the frequent alternation of fresh and salt water productions, seem to have been numerous. On ascending lofty mountains, we find that the remains of animals and vegetables become more rare and finally disappear altogether. The highest rocks contain no vestiges of organization, but they are in a very inclined position, and the ruggedness of their summits evinces the violence with which they have been displaced. Great and sudden changes have therefore taken place in the external crust of our globe, both before and since the creation of living beings. Cuvier examines those now produced by rains and thaws, rivers, the sea and volcanoes, and decides that none of these, by continuing their present operations for any length of time, could occasion the revolutions whose traces are still evident. Nor is any known astronomical cause capable of producing them.

In order to determine with confidence or probability to what power they are to ascribed, it is necessary in the first place to ascertain the precise measure and extent of the phenomena to be accounted for, and to investigate facts before constructing systems. To the neglect of this duty our author imputes the imperfection and variety of geological theories. He gives just praise to Saussure and Werner for their diligence and success in examining the structure and relative position of the principal rocks, but complains that the characters of the fossils discovered in them, their relations to the strata and climates in which they are found, to each other and to the animals now in existence, have never received sufficient attention. 'A consecutive history of these singular deposits would be infinitely more valuable than so many contradictory conjectures respecting the first origin of the world and other planets, and respecting phenomena which have no resemblance whatever to those of the present physical state of the earth; such conjectures finding in these hypothetical facts neither materials to build on nor any means of verification whatever.' From these fossils alone, little as they have hitherto been examined, have we learned that the various substances which constitute the surface of the globe are not of simultaneous formation, and by these alone can we hope to ascertain the time and manner in which the different strata were formed, and the changes which have taken place in them. As the subject is too extensive for the labours of an individual, Cuvier confines his work to the fossil remains of quadrupeds, because this class is best known, Complete fossil skeletons are rarely found, and single bones or fragments of bones are often the only means afforded us to ascertain the species and genera to which they belonged. How well M. Cuvier has qualified himself for this task by the study of comparative anatomy, may be learned from the twenty-seventh Section in which the connexion between the bones of quadrupeds and their modes of life is very ingeniously and minutely exemplified.

'Every organized individual forms an entire system of its own, all whose parts mutually correspond, and concur to accomplish a definite purpose. Hence none of these parts can change their forms without a corresponding change in the other parts of the same animal, and consequently each of them taken separately indicates all the others, with which it was connected. Thus if the viscera of an animal are fitted only for the digestion of recent flesh, the jaws must be constructed for devouring prey, the claws for seizing and tearing it to pieces, the teeth for cutting and dividing its flesh, the entire system of the limbs for pursuing and overtaking it, and the organs of sense for discerning it at a distance.—The smallest fragment of bone even the most apparently insignificant apophysis possesses a fixed and determinate character relative to the class, order, genus, and species of the animal, to which it belonged; insomuch that when we find merely the extremity of a well preserved bone, we are able to determine the species to which it once belonged as certainly as if we had the entire animal before us. I have very frequently tried this method with portions of bones belonging to well known animals, and always with such complete success that I entertain no doubt of its results.'

Our author has described and classified 78 different quadrupeds, 49 of species previously unknown; and has ascertained that oviparous quadrupeds, such as crocodiles and tortoises, are found in more ancient strata than others are; that in those of later formation the bones of mammiferous marine animals, as seals, are first discovered, and in the most recent, those of land quadrupeds. Hence he concludes that as shells are supposed not to have existed when the primitive strata were formed,—being first found in those of more recent origin,—so for the same reason oviparous quadrupeds must have been created still later, and land quadrupeds the last; and that the human race did not exist in the countries where fossil bones are usually obtained, at the time when they were covered, since its remains are not found with those of other animals.

'If there is any circumstance thoroughly established in geology, it is that the crust of our globe has been subjected to a great and sudden revolution, the epoch of which cannot be dated much further back than five or six thousand years; that this revolution buried all the countries before inhabited by men, and by the other animals now best known; that the same revolution laid dry the bed of the last ocean, which forms the countries at present inhabited; that the few men and other animals that escaped from destruction have since propagated and spread over the lands then newly laid dry; and consequently that the human race has only resumed a progressive state of improvement since that period.—Yet further, that the countries now inhabited, and which were laid dry by this last revolution, had been formerly inhabited at a more remote era, if not by man, at least by land animals; that consequently, at least one previous revolution had submerged them under the waters; and that judging from the different orders of animals, whose remains are discovered in a fossil state, they had probably experienced two or three irruptions of the sea. These alternate revolutions form in my opinion the problem in geology most important to be solved, or rather to be accurately defined and circumscribed.'

In selecting for observation the remains of quadrupeds, Cuvier has undoubtedly chosen those, whose examination affords, in the present state of natural history, the most satisfactory results. But there is another department which promises, when sufficiently cultivated, an abundant harvest of geological knowledge—we mean conchology. Of all animal relics, shells are the most numerous, the most perfect, and found in the greatest diversity of situation. They are imbedded in the oldest of the secondary rocks, and may be traced through almost all the subsequent strata; their resemblance to those known to exist at present being greatest in the most recent.

Some are seen in one stratum only; while others are discovered in several successive formations, and thus, according to Cuvier, must have survived many of the revolutions which have changed the face of the globe. A knowledge of the wants and habits of the animals of which they were a part, may enable us to conjecture the reason of this difference, and to form some idea of the process, if not of the cause, of changes thus destructive to some species and harmless to others. The whole analogy of nature, and the little yet known with regard to testaceous animals, justify us in believing that their shells are as perfectly and as curiously adapted to the wants of their occupants, and to the elements and climates which they inhabit, as the bones of a quadruped to his necessities and situation. These animals are the first historians of the earth; they have left behind them the earliest and most connected records of animal existence, and of mineral revolutions. To understand their language is one of the most important and interesting objects of conchology. It is obvious that the first step towards its attainment is an intimate acquaintance with the structure and habits of the animals of that class now living on the earth, and a knowledge of the relations between their peculiarities of form and the conditions of their existence.

It is not the least merit of this work of Cuvier, that it can be understood by the unlearned; and is not incumbered with that superabundance of technical terms which too often renders the school of Werner unintelligible, even when speculating on those general topics which every one is capable of comprehending. The whole treatise fills about one hundred and fifty pages, and cannot fail to be highly interesting to every inquisitive mind. The notes of Jameson, occupying as many pages more, are principally devoted to an account of the animals described by Cuvier, in his work on the fossil remains of quadrupeds, to a mineralogical description of the vicinity of Paris,—abstracted from an essay on that subject by Cuvier and Brogniart, stating the nature and relative position of the strata, and describing the organic remains found in each,—and to a similar description of part of the South of England. These notes are appropriate, and will excite the attention of many readers; but those which attempt to vindicate some of the doctrines of Werner not adopted by Cuvier, and those which describe so minutely the formation of alluvial land, and the transportation of sand,—subjects mentioned only incidentally in the text,—might have been spared as having little relation to a work, whose object is to display the importance of studying the characters and situation of fossils, and the results already attained by that study. It is to be regretted that a book, capable of pleasing and instructing every body, should thus unnecessarily have its size increased, and its circulation of course diminished.

If some of Jameson's notes are irrelevant, what shall be said of the observations on the geology of North America, introduced in the American edition as an appendix? After assenting to the opinion of Mr. Maclure, that the organized remains found in our country have not been examined with the accuracy necessary to form just conclusions, its author proceeds to draw from them some conclusions, whose pretended precision, if not their novelty, may well startle us. The accomplished mineralogist just named has conjectured that the space between the Alleghany and the rocky mountains was once the bottom of a lake. On this hint the writer of the appendix speaks, points out the mountains which formed the shores of this vast lake, and wherever the range is interrupted, fills the gap with a conjecture,—'it is reported to be distinguishable,'—'I entertain no doubt the entire or broken chain will be found,' &c. He states that this grand barrier has been broken through in several places, and mentions eleven breaches, which, as he says, have come to his knowledge. We have then a particular account of the changes wrought within these limits subsequent to the bursting of the barrier, and afterwards a description no less particular of the lakes formerly existing on its outside, including those of the Connecticut, Hudson, St. Lawrence, Delaware, Schuylkill, Potomac, and James Rivers. We would not condemn such conjectures when briefly stated; they awaken the zeal of the geologist, and direct his attention to investigations which may lead to useful discoveries. But the minuteness and prolixity with which this appendix heaps conjecture upon conjecture, and possibility upon possibility, to describe with geometrical precision the face of the country when half covered by water, and all the channels through which the water has retired, are by no means laudable. Such details have little connexion with the work to which they are subjoined, and exhibit none of that cautious spirit of induction, by which the author of that work is distinguished.

The other book, whose title is prefixed to this article, is humbler in its pretensions, being merely a description of the minerals found in the vicinity of Boston. The authors profess to insert only characteristics noticed by themselves, and geological facts ascertained by their own observation. This seems to us a defect in their plan. The most striking peculiarities of any mineral specimen, and of any tract of country, appear to every observer in nearly the same light. Hence the greater part of such a work as this must be a repetition of what has been previously observed, and can add nothing to our knowledge but the support of new testimony. If it included the few remarks of other geologists of unquestionable skill, which its authors have not had an opportunity of verifying, it would have the additional advantage of presenting a complete statement of every thing known on the subject of which it treats, without being increased more than two or three pages in size. An analysis of each mineral should also have been subjoined on the best authority. Whatever may be thought of making chemistry the basis of mineralogical classification, it is certainly a material part of the description of a mineral to state the substances of which it is composed.

The name of Chelmsfordite is given in this work to a substance found in carbonate of lime near Chelmsford, and which is classed as a subspecies of Schaalstein; differing from it, as we are told in the 'Outlines,' by being phosphorescent when placed in powder on a heated iron, and not so like Schaalstein when rubbed with an iron point; also by its imperfect tabular structure, and by its fusibility. Schaalstein is brilliantly phosphoric when thrown on hot iron, and if the mineral discovered at Chelmsford did not appear to be so when rubbed by an iron point, it may perhaps be attributed to some inaccuracy in the experiment, or to some impurity in the specimen. The imperfection of its tabular structure does not seem to render a new name necessary, and we know not where our authors have learned that Schaalstein is infusible. "It melts easily before the blow-pipe with slight ebullition into a white glass."* No material distinction is shewn therefore between this mineral and Schaalstein; but without either comparison or analysis we dare not assert their identity.

The most singular and important discovery, if correct, mentioned in this work, is that of basalt, a mineral never before found in the United States, and to whose absence the undisputed triumph of the Wernerian theory among us has in part been attributed; for this rock is the corner stone of the Huttonians and a stumbling block to their adversaries. The geological situation of the mineral to which these authors give that name, and the substances imbedded in it, are unfavourable to their opinion. It is said to be found in Argillite and to contain scales of black mica. Basalt contains mica only when it borders on Wacke and is passing into it. The characteristic, which distinguishes wacke from basalt according to Brochant, is the dissemination through the mass of separate hexagonal crystals of black mica. Besides, the mineral found near Boston is not said to contain olivine, the almost inseparable companion of basalt. Is it not possible therefore that this substance may be incorrectly named, and may be a greenstone occasionally found in our vicinity, to which the name of basalt has often been given? We cannot forbear suspecting also that the mineral called wacke in this book is greenstone in a state of partial decomposition; for no pure wacke has hitherto been found here, and experienced mineralogists have been deceived by the similarity of these substances.

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* Hausmann's Mineralogy.—Tafelspath.

It is essential to grey wacke, if those who introduced the term may be allowed to define it, that its cement be argillaceous; hence its grey streak and its name; and hence its distinct stratification. The pudding stone of Roxbury is not apparently stratified, and is a siliceous aggregate cemented not by argillaceous matter but by minute fragments of the stones composing its mass. In this instance however our authors have not erred without authority. Mr. Godon gives to this substance, though with evident hesitation, the name of grey wacke; and Mr. Cleaveland in his late work has varied the definition of that term, so as to embrace the rock to which it had been thus erroneously applied.

We do not agree with our authors in thinking it unphilosophical and injurious to represent vertical sections of a country; for every body understands that they are not proofs of any theory, but only illustrations of it. They ought always however to be accompanied by a minute account of the observations on which they are founded.

The work now under consideration is the only methodical description of the minerals in our neighbourhood, and notwithstanding the few defects above noticed, demands for its authors the praise due to zeal and diligence, and may be recommended to students in our vicinity as a useful manual. The means of improvement in mineralogy have very much increased in this part of the country within a few years; the best books on the subject may be found here, and we have lately had an opportunity of listening to the public instructions of a skilful mineralogist and agreeable lecturer, illustrated by a collection of minerals which can have very few equals in America. We hope that our University will soon be roused from its long neglect of this study, will cause its few but valuable specimens to be properly arranged, and derive from the diligent cultivation of the science some honour for itself and some benefit for the community.

ART. XVI. *An Anniversary Discourse delivered before the New York Historical Society, December 7,* 1818, *by Gulian C. Verplanck, Esq.* pp. 121. New York, 1818.

THE singular advantages which we possess, for tracing the origin and progress of the several settlements in our country, have often been the subject of remark. It is obviously true, in regard to the leading features of our history, that we have many peculiar facilities for their precise determination; but there is a variety of circumstances, relative to characters and incidents, which would give completeness to our history, that are buried in obscurity, or exist in an evanescent form. Some valuable repositories of documents of this description have been unhappily destroyed or impaired by fire, war, popular commotions, or some other calamity. To collect, preserve and publish such authentic historical remains were the objects in view in the formation of the Massachusetts Historical Society, in 1791. The public has witnessed and commended their industry. Seventeen volumes of their Collections have been published, in which is included the History of New England prepared by the venerable Hubbard, at the close of the seventeenth century. A generous emulation, in this course of filial regard to the memory of our ancestors prompted to the institution of a similar society in New York, in 1809. More recently, in Pennsylvania, by a modi-